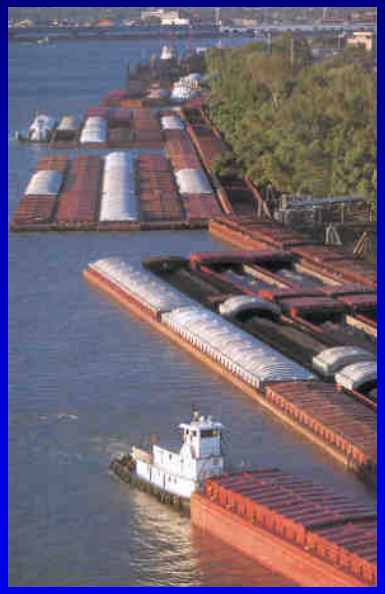
ERDC Navigation Research

Inland Navigation CoP Workshop
September 19-20, 2007
Louisville, KY



Presenters: Jim Clausner, John Hite
Technical Programs Office, CHL

Navigation Research Programs

- Navigation Systems (NavSys)
- Dredging Operations and Environmental (DOER)
- Dredging Operational Technical Support (DOTS)
- Inland Electronic Navigation Charts (IENC)
- Monitoring Completed Navigation Projects (MCNP)
- Coastal Inlets Research Program (CIRP)
- Regional Sediment Management (RSM)

Navigation Systems
"An Integrated Program"

- ERDC Labs
  - Cold Regions Research Engineering Lab
  - Construction Engineering Research Lab
  - Coastal and Hydraulics Lab
  - Geotechnical and Structures Lab
  - Information Technology Lab
  - Topographic Engineering Lab
- Institute for Water Resources
- Efforts integrated with other Research Programs
- **Industry Input/Cooperation**

Navigation Systems
"Current R&D Program"

- Deep Draft Channels and Harbor Design
  - Vessel Effects, Deep Channel Design
- Coastal Structure Design
- Hydrodynamic Design of Inland Structures
- Inland Infrastructure
  - Inspection
  - Condition Assessment
  - Inventory Management System
  - Predicative Maintenance
  - Rehabilitation
  - Safety
    - Vessel Impacts
    - Outdraft

Navigation Systems
Focus Areas

- Deep Draft Navigation
- Inland Navigation
  - Hydrodynamics
  - Infrastructure

Deep Draft Work Units, Vessel Effects

Work Units

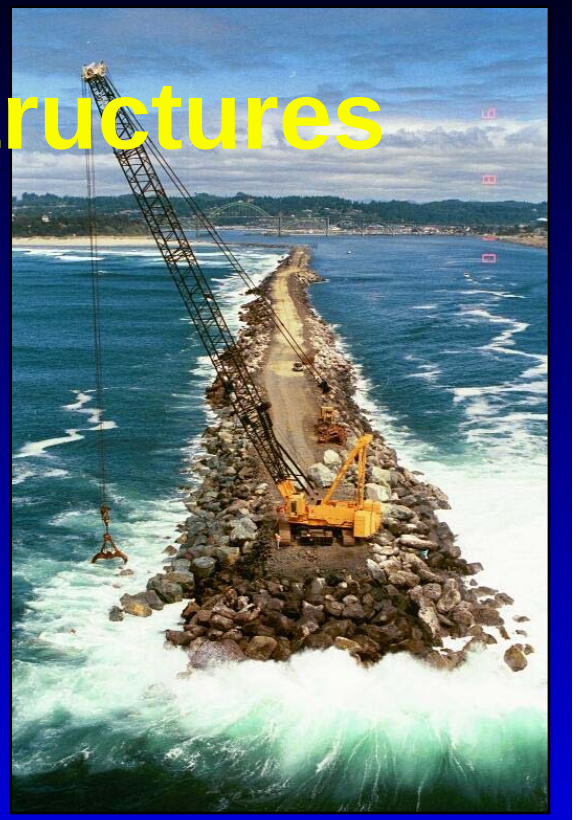
- Improved Ship Simulations
- Improved STS Vessel/Current Interaction
- High Fidelity Vessel Effects

Added Capabilities

- Improved tools for STS, Ship Squat, Vert. Motions
- Hydrodynamic influences of vessel on flow field real-time basis
- Model for vessel generated waves and other complex fluid flow

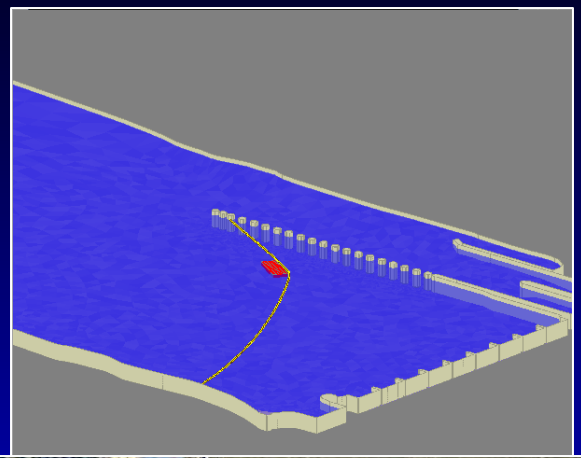
Risk Analysis of Coastal Structures

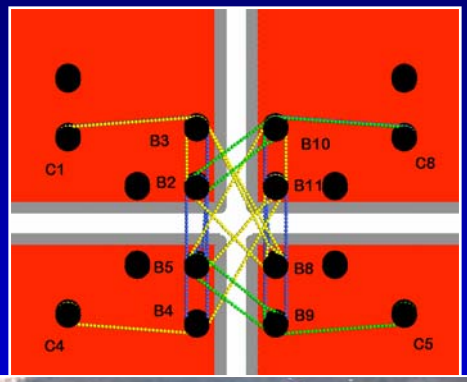
- PI: Jeffrey Melby, PhD
- Team: Steve Hughes, Prof. Kobayashi, Prof. Kriebel, IWR
- Capability
  - Have CEM, CEDAS, SMS, and generalized @Risk
  - Lacking applied risk analysis methods/tools, physics-based design, modern computer models and examples
- Products:
  - Physics-based design methods, Damage models
  - Reliability methods/partial safety coefficients
  - Risk methods/programs
  - Case studies/examples, spreadsheet applications
  - Web Page for all Corps structures
- Benefits:
  - Improved design/analysis tools
  - Reduced costs for breakwater, jetty design/rehab
  - Better planning/scheduling



Inland Navigation Research Areas

- Hydrodynamics
- Infrastructure

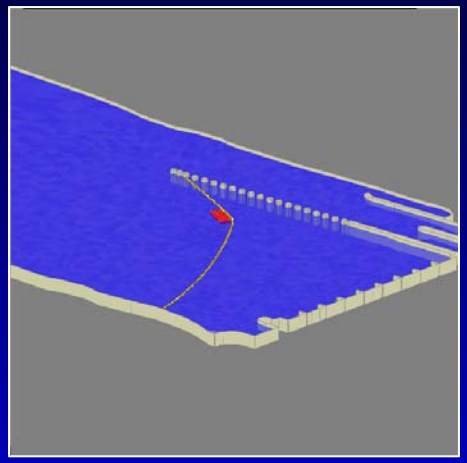


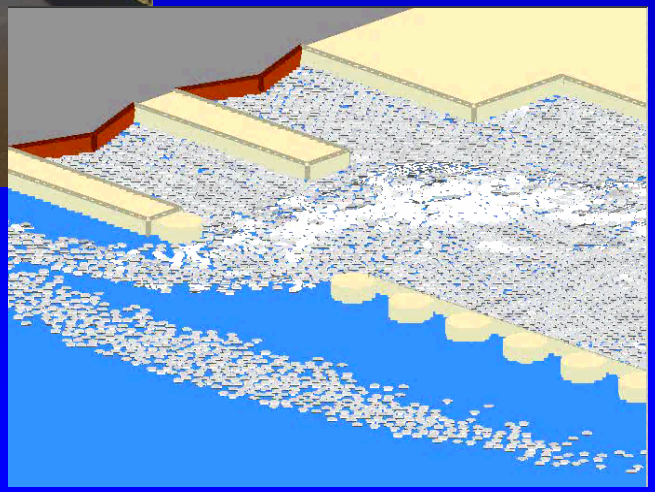


Focus Area Leader: John Hite

Hydrodynamic Design of Inland Structures

- Capability Being Developed
  - Model ice and debris at locks.
  - Integration of structural and hydraulic modeling (Ice & debris, tows, guard walls, gates, barge impacts)

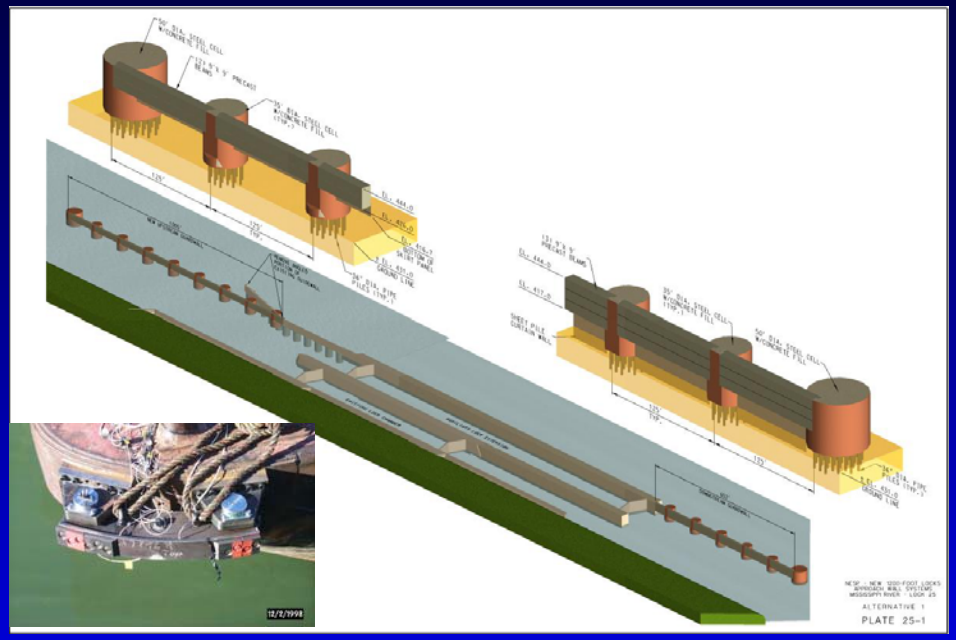




- Benefits: Simulation Tool
  - Unique ability to model fluid/structure interactions.
  - Placement of emergency lock bulkheads and dam gates. (hydraulic forces during placement).
  - Placement of float-in lock components.

Vessel/Barge Impact

- **Capability Being Developed**
  - Engineering methodologies for the complete impact-induced deformation based interaction between the structure and it's foundation will be based on 1) energy balance procedure and 2) structural dynamics (time varying force applied to the structure)

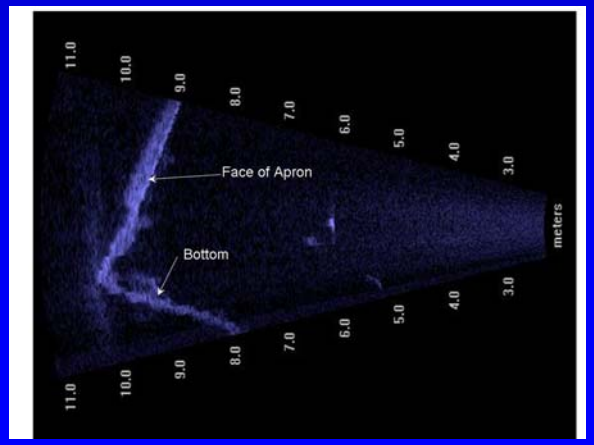


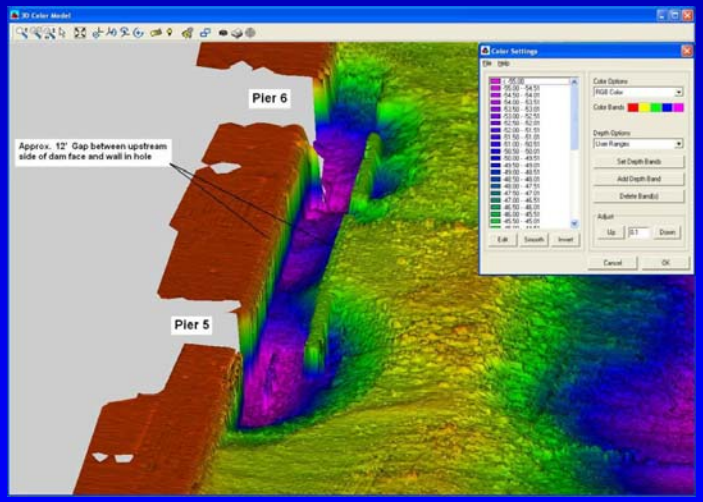
- **Benefits:**
  - Cost savings by determining realistic values for impact loads for utilization in the design guidance for flexible impact walls
  - Updated design guidance for impacts with rigid walls

Detection of Scour

- **Capability Being Developed:**
  - Underwater inspection of scour protection
- **Benefits**
  - Process to assess repair needs
  - Better prediction of maintenance/rehab costs
  - Reduced chance of failure

Underwater Imaging

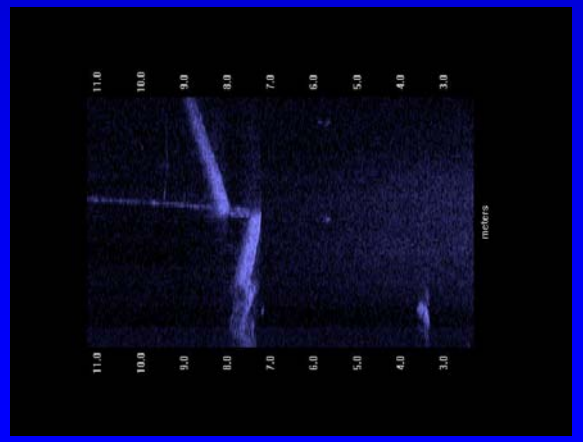




$$\beta = \frac{\ln(|C| \cdot |D|)}{\sqrt{V_C^2 + V_D^2}} = 1.03$$

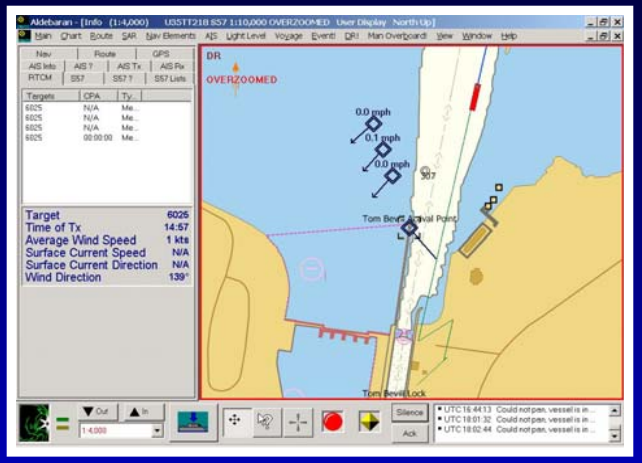
Acoustical Camera Demonstration

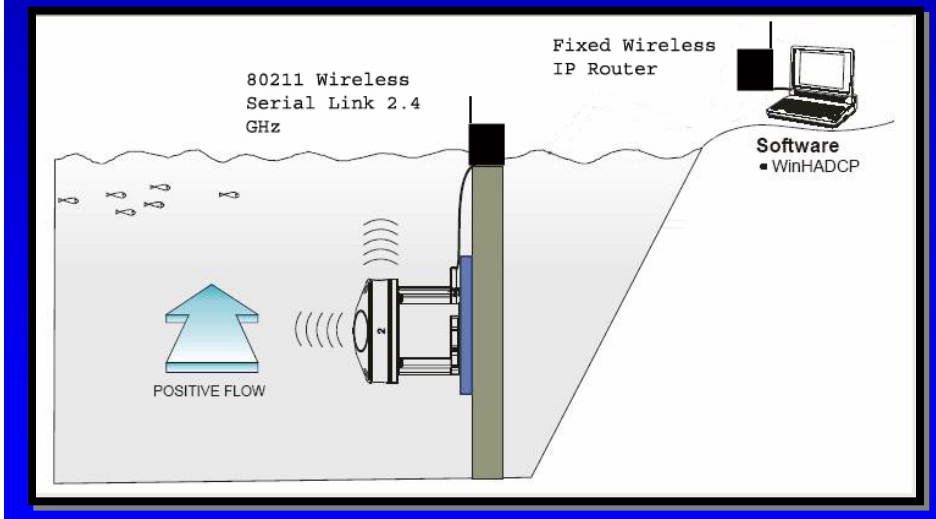
Tracking Total Station for Position



Real Time Current Velocity System

- **Capability Being Developed**
  - **Real Time Outdraft Measurement that is transmitted to Tows approaching a Corps Lock and Dam**





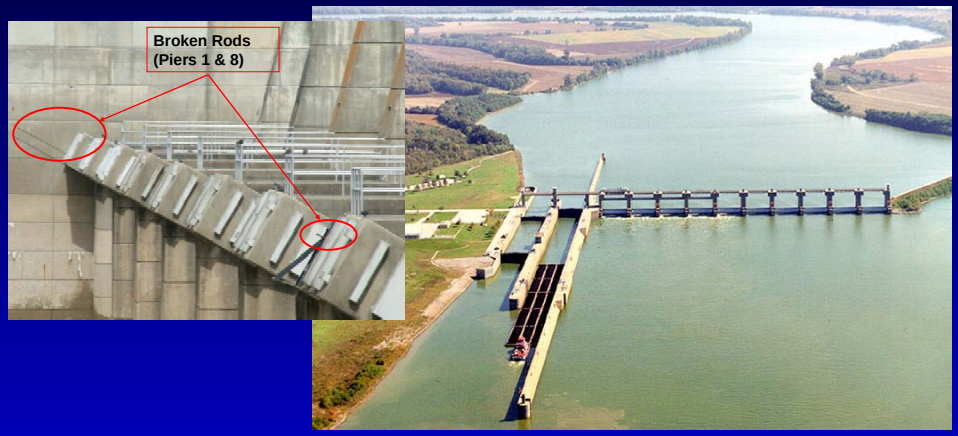
- **Benefits: Improved Safety on Inland Waterways**
  - **Real Time Data provided for the Mariner to make better decisions**
  - **Utilizing AIS Network**
  - **Ability to Direct Marine Traffic and Transmit Lock Schedules to a Que**

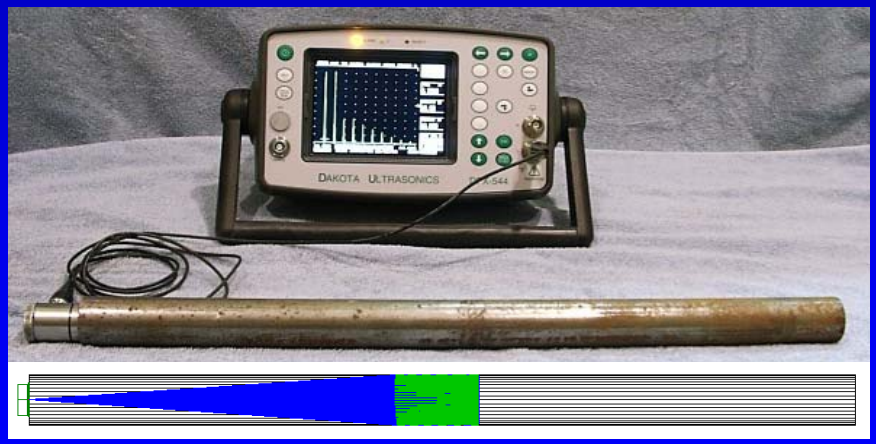
Steel Cracks and Welding

- **Capability Being Developed**
  - Criteria for performing fitness for service assessments
  - Analytical techniques for numerical fracture mechanics analysis
  - Analytical models to assess the pre-stress requirements of miter gate diagonals
- **Benefits**
  - Consistent and systematic guidance for performing a fitness for service assessment
  - Detailed fracture analysis
  - Reassessment of miter gate diagonal design criteria

NonDestructive Condition Monitoring for Tensioned Steel Members

- **Capability Being Developed**
  - NonDestructive test technique for quantitatively measuring tension and corrosion of steel members



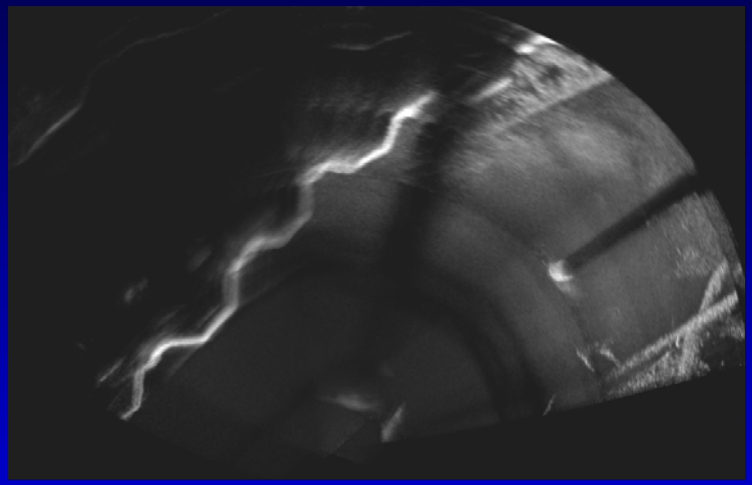


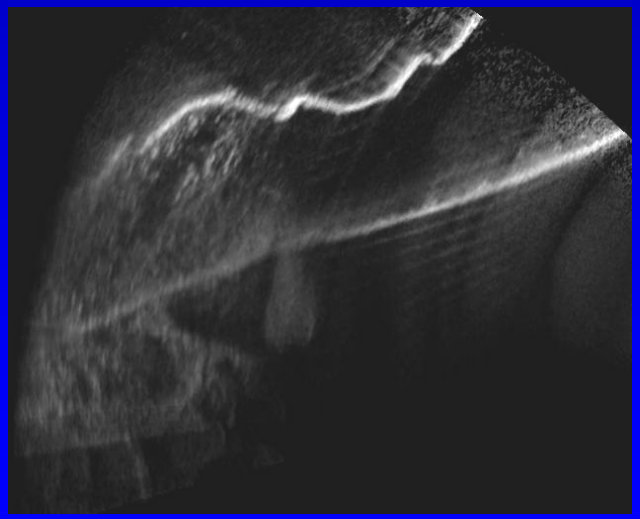
- **Benefits:**
  - Rapidly measures tension
  - Works with only limited access to part
  - Provides evaluation of fitness for service
  - Improved infrastructure reliability
  - Decreased maintenance costs

Inspection and Condition Assessment of Steel Hydraulic Structures

- **Capability being developed**
  - procedure for the inspection of gates using an acoustical camera
  - Development of a satisfactory deployment system and methods to enhance the images for the acoustical camera

- **Benefits**
  - Improved quality of inspections
  - Reduced cost of inspections
  - Reducing personnel risk
  - Real time permanent record





Mosaiced acoustical images of sheet piles at Mel Price Dam, Mississippi River

Robotic Inspection of Corps Structures

- **Capability Being Developed**
  - Widespread use of Remotely Operated Vehicles (ROVs) to inspect Corps structures

- **Benefits**
  - Lower inspection costs
  - Higher inspection rates
  - Less unplanned outages
  - Better asset management
  - Improved public safety

Innovative Lock Repair Techniques

- **Capability Being Developed**
  - **Repair of frost damaged concrete**
  - **Managing alkali-aggregate reaction**

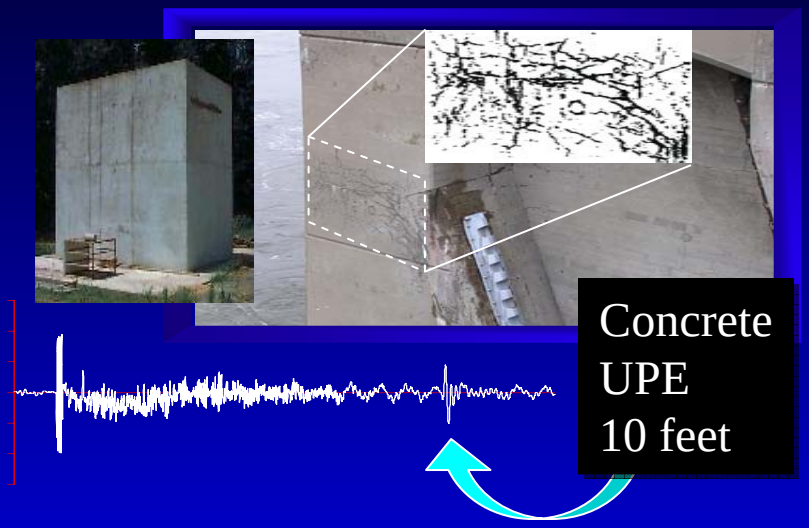
cycles of freezing & thawing

ASR

- **Benefits**
  - **Tools for interim repair**
  - **Tools for Asset Management**

Condition Assessment and Monitoring of Concrete Structures

- **Capabilities Being Developed**
  - Enhanced ability to detect and quantify deterioration using new and improved tools to support inspection and assessment of mass concrete structures

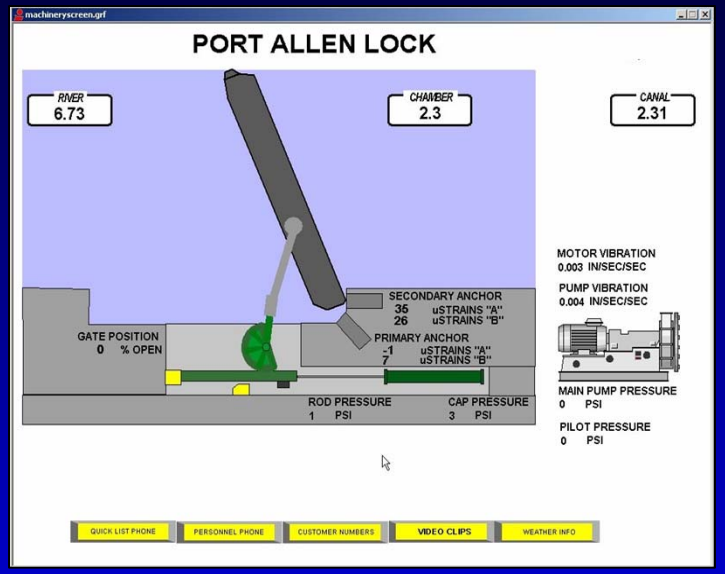


- **Benefits:**

  - Increased ability to develop long-term plans for maintenance and repair to facilitate the effective use of available resources and help insure continued operation of the navigation system.

Asset Management
Condition Monitoring for CW Infrastructure

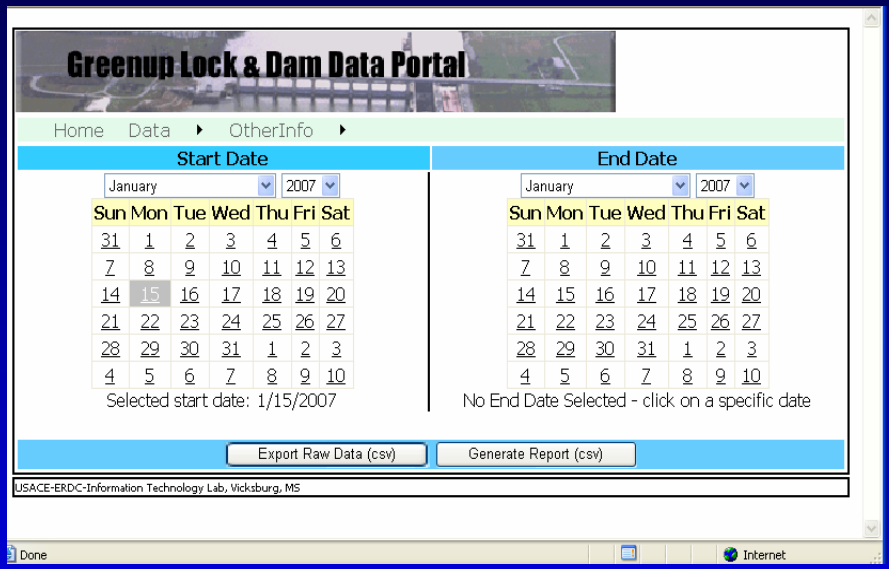
- **Capability/Products:**
  - Condition monitoring baseline data for:
    - Structural components
    - Lock operating machinery
  - Guidelines for Predictive Maintenance



- **Benefits:**
  - Real-time indication of electrical, mechanical and structural condition
  - Reduces fracture critical component failure
  - Reduces maintenance cost and personnel requirements
  - Improves safety and reliability of lock gate, dam gate and pumping station operations

Real-Time Data Management for Structural Monitoring – A Demonstration Project

- Capability Being Developed
  - A robust, adaptable data management architecture and user interface that will allow the structural engineer instant access to real-time sensor data for condition assessment



- Benefits: Improved condition monitoring for
  - Miter gates
  - Tainter gates
  - Trunion anchors
  - Dams and Levees

US Army Corps of Engineers.

Results of Outdraft

US Army Corps of Engineers.

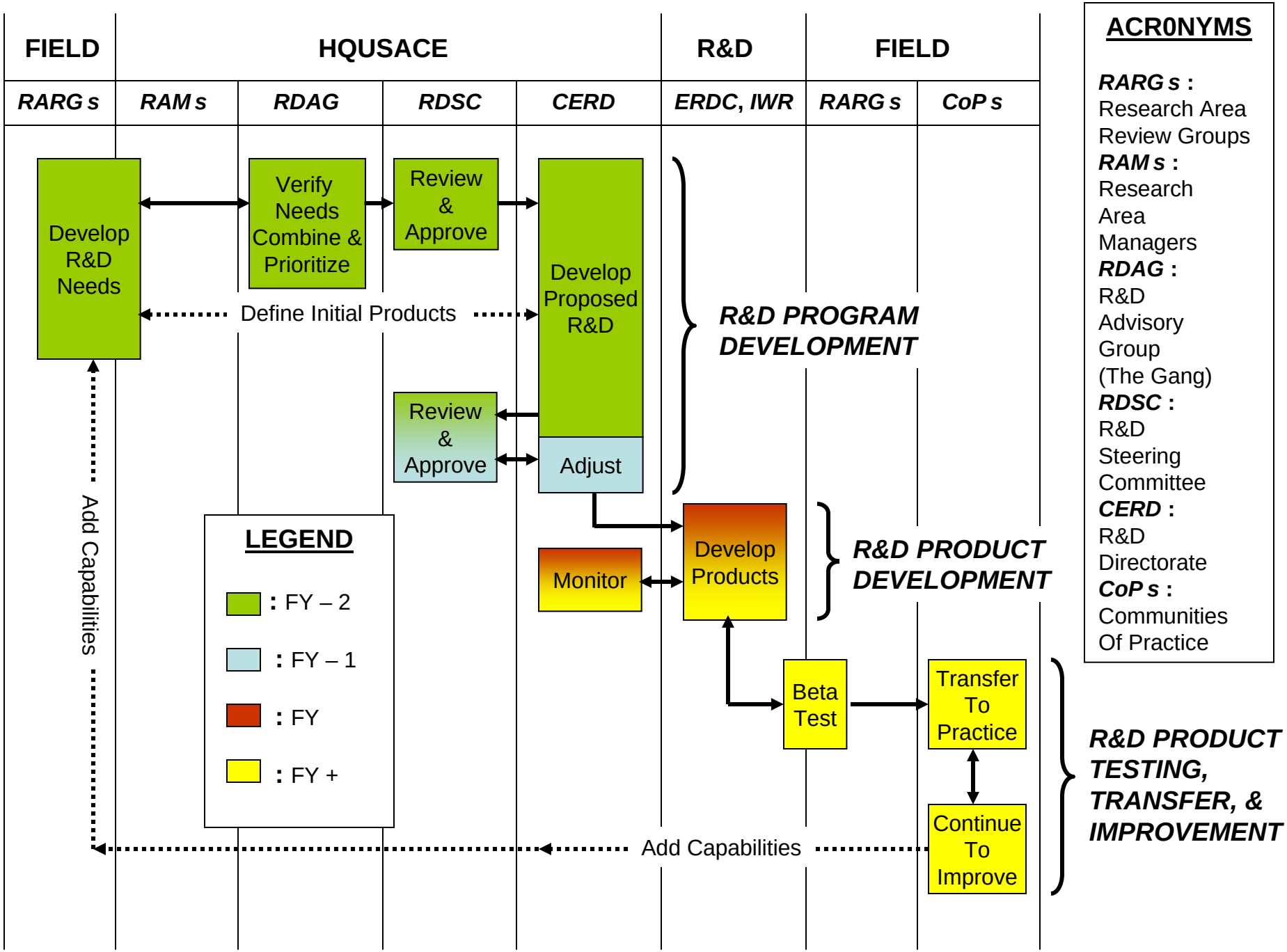
Lock Distance Measurement System

- Capability Being Developed
  - Every Vessel Receives Real Time Distance
  - Distance Can be Transmitted by AIS
  - Displayed on IENC's Providing ±3ft Accuracy

US Army Corps of Engineers.

Navigation Safety Initiatives
The Way Ahead (cont'd)

- AIS demonstration projects:
  - Louisville, KY – McAlpine Lock – USCG/Corps
  - Galveston, TX – Galveston Causeway Bridge – USCG/NOAA/Corps – with nav industry purchasing and maintaining the equipment


FIELD
HQUSACE
R&D
FIELD
RARG s
RAM s
RDAG
RDSC
CERD
ERDC, IWR
RARG s
CoP s
Develop R&D Needs
Verify Needs Combine & Prioritize
Review & Approve
Develop Proposed R&D
Define Initial Products
R&D PROGRAM DEVELOPMENT
Review & Approve
Adjust
Add Capabilities
LEGEND
: FY – 2
: FY – 1
: FY
: FY +
Monitor
Develop Products
R&D PRODUCT DEVELOPMENT
Beta Test
Transfer To Practice
Continue To Improve
Add Capabilities
R&D PRODUCT TESTING, TRANSFER, & IMPROVEMENT
ACR0NYMS
RARG s : Research Area Review Groups
RAM s : Research Area Managers
RDAG : R&D Advisory Group (The Gang)
RDSC : R&D Steering Committee
CERD : R&D Directorate
CoP s : Communities Of Practice

Questions

- http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=Programs;4